

CLAIMS

1. Device for separating magnetic or magnetizable particles (30) from a liquid by using a magnetic field, wherein
 - said device (1) comprises two limbs (2, 3) made of a soft-magnetic material;
 - between the two poles (4, 5) of the limbs (2, 3) there is an air gap (12) which is suitable for receiving a container or a plurality of containers (9, 10);
 - a head piece (8) is arranged in a fixed or detachable manner on one of the two poles (4), and a magnetizable bar or a plurality of magnetizable bars (7) is/are disposed in a fixed or movable manner on said head piece, in the vertical direction;
 - a permanent magnet (15) or a group of at least two permanent magnets is movably arranged on at least one point of the device, such that a magnetic field (17) can be produced between the two poles (4, 5) and the magnetic field can be activated or deactivated by moving the magnet(s) (15), and wherein
 - that region of the device wherein the movable magnet(s) is/are arranged is at least partially surrounded by a material (20) which screens the magnetic field.

2. Device according to claim 1, characterized in that the two limbs (2, 3) are connected with each other at the side (6) opposite the poles (4, 5) and thereby form a magnetic circuit (iron circuit).

3. Device according to claim 1 or 2, characterized in that the magnet(s) is/are arranged within the iron circuit such that they are movable, particularly rotatable, or that the magnet(s) is/are arranged such that it/they can be moved into the magnetic circuit from the outside and then again out of the said circuit.

4. Device according to any one of the preceding claims, characterized in that the region of the device wherein the movable magnet(s) is/are arranged within the iron circuit is at least partially surrounded by a material which screens the magnetic field.

5. Device according to any one of the preceding claims, characterized in that in the case of the magnet(s) moving within or into the iron circuit, the region of the device wherein the movable magnet(s) is/are arranged within the iron circuit is at least partially surrounded by a material which screens the magnetic field.

6. Device according to any one of the preceding claims, characterized in that the permanent magnet(s) are arranged such that they are rotatable or tiltable, in a recess (16) provided for that purpose.

7. Device according to any one of the preceding claims, characterized in that the permanent magnet(s) is/are provided in a displaceable manner, in a recess (16) provided for that purpose.

8. Device according to any one of the preceding claims, characterized in that the permanent magnet(s) is/are arranged on a rotatable support (40) by means of which the said permanent magnet(s) can be moved into the magnetic circuit and then again out of the said circuit.

9. Device according to any one of the preceding claims, characterized in that the movement of the permanent magnet(s) is accomplished by means of an electric motor or by pneumatic or hydraulic means.

10. Device according to any one of the preceding claims, characterized in that the extent of the movement, particularly the rotation angle or the distance of displacement, of the permanent magnet(s) can be predetermined in order to set the magnetic field strength to a desired value.

11. Device according to any one of the preceding claims, characterized in that the region of the magnetic circuit wherein the movable magnet(s) is/are arranged is completely surrounded by a material which screens the magnetic field, said screening preferably being provided in the form of a short circuit ring (20).

12. Device according to any one of the preceding claims, characterized in that the said head piece (8) is movable in the horizontal plane, preferably for carrying out a shaking motion.

13. Device according to any one of the preceding claims, characterized in that the said head piece (8) carries a plurality of bars (7) arranged in rows.

14. Device according to any one of the preceding claims, characterized in that the head piece (8) is attached in a replaceable manner.

15. Device according to any one of the preceding claims, characterized in that the said bar(s) (7) are arranged in a rotatable manner and can preferably be rotated around the longitudinal axis by means of an electromotive drive.

16. Device according to any one of the preceding claims, characterized in that the said bar(s) (7) are each covered with a strippable, replaceable envelope (25).

17. Device according to any one of the preceding claims, characterized in that at least one holding device (11) for the said container(s) (9, 10) is associated to said device, which holding device (11) is suitable for positioning the container(s) below the said head piece and the bars arranged thereon.

18. Device according to claim 17, characterized in that the said holding device(s) can be moved in the horizontal plane and/or vertically, preferably by electromotive drive or by pneumatic or hydraulic means.

19. Device according to claim 18, characterized in that the holding device(s) is/are adapted for carrying out shaking movements.

20. Device according to any one of claims 17 to 19, characterized in that the holding device(s) is/are a component of a program-controlled laboratory robot system and is/are adapted such that a plurality of individual ones of the said containers or of groups of such containers, particularly microtitre plates, are alternately moved into a position below the said bars and subsequently, after a predetermined time interval, again into a position which is outside the region below the bars.

21. Device according to any one of claims 17 to 20, characterized in that the vertical motion of the holding device(s) (11) can be open-loop controlled or closed-loop controlled by an open-loop control unit or a closed-loop control unit, in such a manner that in the case of an upward movement an immersion of the bars (7) into the liquid-filled containers (10) is caused.

22. Device according to any one of the preceding claims, characterized in that a program-controlled processor is associated to the device and is connected therewith, by means of which at least one of the following functions of the device can be open-loop controlled or closed-loop controlled, or by means of which at least two of the functions mentioned below can be coordinated with one another:

- movement of the permanent magnet(s) to activate and deactivate the magnetic field, particularly the dura-

- tion of the activated and deactivated phases, as well as magnetic field strength;
- rotation speed and duration of rotation in the case of rotatable bars;
 - movement of the head in a horizontal plane, particularly duration, frequency and amplitude of a shaking motion;
 - movement of the holding device(s) to position the container(s) or groups of containers alternately below the bars and subsequently to remove them from that position, particularly the velocity and frequency of the movements, as well as the dwell time of the holding device below the bars;
 - vertical movement of the holding device to immerse the bar/the bars into the liquid of the container(s) and remove the same therefrom; particularly immersion depth, duration and frequency;
 - if provided, rotation or shaking motion of the holding device(s), particularly rotation speed, rotation amplitude and intervals between the individual operation phases.

23. Device according to one or more of the preceding claims, characterized in that one or more of the below-mentioned means are associated to the said device, the functions of said means being coordinated with the functions of the said device by means of a common control:

- one or more thermostatable heating or cooling means;
- one or more pipetting stations for metered addition of liquids, especially reagents;

- one or more suction means for exhausting liquid from the containers by suction;
- one or more means for shaking or intermixing the liquids contained in the containers;
- analytic apparatuses, particularly for photometric measuring or luminescence detection.

24. Device for separating a target substance from a mixture of substances which is present in liquid form, comprising the following steps:

- a) addition of magnetic or magnetizable particles that have specific binding properties in relation to the target substance;
- b) placing a pre-determined volume of the mixture in the air gap between the two poles of a magnetic circuit and immersing a magnetizable bar into the mixture, said bar being connected with one of the said poles of the magnetic circuit, and the magnetic field being initially deactivated;
- c) activating the magnetic field by changing the position of a permanent magnet arranged in or on the magnetic circuit, whereby the bar is magnetized and the particles accumulate substantially at the lower end of the bar;
- d) immersing the bar, together with the particles adhering thereto, into a predetermined volume of a liquid that causes the elution of the target substance from the particles;
- e) lifting the bar out of the elution liquid.

25. Process according to claim 24, characterized in that, following step d), the following steps are performed:

- f) deactivating the magnetic field by an opposite change of the position of the permanent magnet, whereby the particles are released into the liquid;
- g) mixing;
- h) activating the magnetic field by changing the position of a permanent magnet arranged in or on the magnetic circuit, whereby the bar is magnetized and the particles accumulate substantially at the lower end of the bar;
- i) lifting the bar out of the elution liquid.

26. Process according to claim 24 or 25, characterized in that, following step c), the following steps are performed:

- k) immersing the bar, together with the particles adhering thereto, into a pre-determined volume of a wash liquid;
- l) deactivating the magnetic field by an opposite change of the position of the permanent magnet, whereby the particles are released into the liquid;
- m) mixing;
- h) activating the magnetic field by changing the position of a permanent magnet arranged in or on the magnetic circuit, whereby the bar is magnetized and the particles accumulate substantially at the lower end of the bar;
- l) lifting the bar out of the elution liquid;
- m) elution of the target substance, as in steps d) and e) of claims 24, or according to claim 25.

27. Process according to any one of claims 24 to 26, characterized in that it is carried out by using a device according to any one of claims 1 to 23.